Operational boundary layer height determination with in-situ and ground-based remote sensing instruments: validation and first climatology on the Swiss plateau.

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The planetary boundary layer (PBL) is the lowest part of the troposphere that is directly influenced by the Earth's surface and concentrates the major part of aerosols as well as others pollutants. Continuous determination of PBL height is of prime importance for air quality analysis, for predicting aerosols, pollens and pollutants dispersion, and for local meteorological climate comprehension.

The top of the PBL is characterized by a strong decrease of the aerosol concentration and humidity content as well as by strong turbulences. It can be consequently estimated by measuring various physical parameters such as the aerosol scattering ratio (ASR) measured by the Raman-lidar, the RH gradient measured by the radiosonde (RS) or the Raman-lidar, or the turbulence signature in the signal to noise ratio (SNR) of the windprofiler. The radiosonde and the microwave radiometer provide temperature profiles to which both Parcel Method (PM) and bulk Richardson (bR) can be applied to detect the PBL height by the elevation of air masses adiabatically raised by convection. The numerical weather prediction (NWP) model COSMO-2 also used the bulk Richardson method to determine the PBL height.

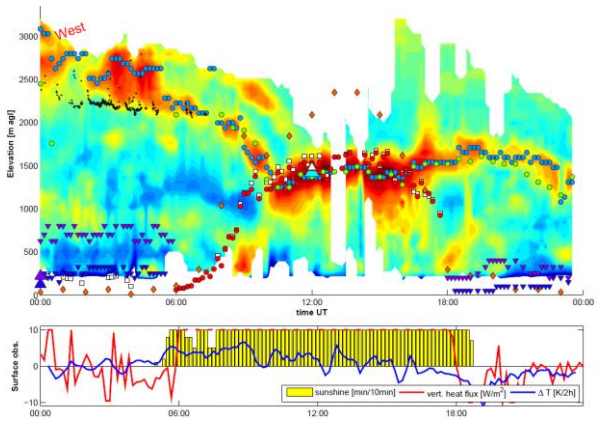

Figure 1: PBL height detected by the PM (red circles + triangle) and the bR (white squares +triangle) applied on the radiometer and radioSonde T profiles, on the SNR (blue circles) on the ASR (green circles) and nocturnal SBL height detection (blue and violet triangles), as well as COSMO-2 output (orange diamond), 31 July, 2012 at Payerne. The sunshine duration, the vertical heat flux and the temperature gradient are plotted on the second panel.

All the PBL height detection methods are operationally applied to all instruments in Payerne (491 m asl) and Schaffhouse (437 m asl) situated on the Swiss plateau. The 2012 data were used to validate the detection methods taking the PM applied on the radiosonde or the radiometer T profiles as a reference method and to calculate a climatology of both the CBL and the SBL at both measuring sites. Figure 1 presents an example of clear sky convective day, where 1) the convective boundary layer (CBL) height's increase and decrease can be detected by the PM applied to the radiometer data, 2) all detection methods show a very good agreement for the CBL height during the afternoon, 3) the residual layer is detected by both the windprofiler and lidar, 4) the nocturnal stable layer (NSL) is evaluated by the radiometer and radiosonde T profiles, and 5) the COSMO model shows a clear overestimation of the CBL height for this day.

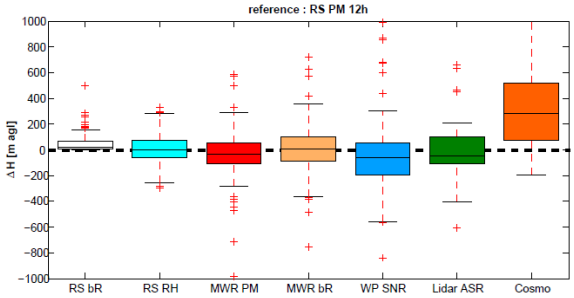

Figure 2: Boxplots of ΔH between PBL height computed at 12:00 UT with various methods and the reference RS PM. The central mark is the median, the edges of the box are the 25th and 75th percentiles q1 and q3, the whiskers extent covering 99% of data assuming a normal distribution, and the red crosses are the outliers.

The validation (Fig. 2) done on 107 convective days during January-October 2012 shows that all the detection methods based on remote sensing and radiosonde measurements are in very good accordance (mean at ± 50m, 25th and 75th percentiles at ± 200 m). The COSMO CBL height being on the contrary regularly overestimated for part of the summer days.

One year climatology shows that both in Payerne and Schaffhouse, the PBL height obeys a remarkable annual cycle, varying between about 400 m agl in winter up to nearly 1400 m agl in July. The PBL maximal height appears to be reached from May to August.